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15 June 1962

Special Projects Office (LMBA-1)
Plans & Programs Office
Directorate of Production
Wright-Patterson Air Force Base, Ohio

SUBJECT: Monthly Progress Report
Contract AF 33(600)-40280

Enclosure (1): Three (3) copies Monthly Progress Report for Period April 15, 1962 to May 15, 1962.

Gentlemen:

Enclosure (1) is submitted as required by the subject contract. One copy of this report is also being sent to [redacted] 25X1

[redacted] 25X1

Very truly yours,

WESTINGHOUSE ELECTRIC CORPORATION

[redacted] 25X1

Project Liaison
Marketing Department

RWE:mfs

cc: [redacted] 25X1

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Progress Report

Period of April 15, 1962 to May 15, 1962

Contract No. AF33(600)40280

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Flight S-12 was made on May 10 but no results were obtained because of low power output.

An improved recorder has been installed in the aircraft for flight S-13. A preliminary resolution test was made on a piece of film from this recorder using the special test equipment film evaluator and an azimuth frequency response of 300 cps was obtained. This test will be made again and curves obtained to determined optimum adjustments for best frequency response.

2. Oscillograph Data

In the past reporting period, five flights were flown at 17,000 or 20,000 feet and speeds of 530 to 585 knots. Facilities to record both antenna beam velocity and antenna beam acceleration have been manufactured but no data was obtained since the accelerometer was disconnected because of excessive pick-up in the leads. This is being corrected. The problem of selecting the proper offset frequency so the holograms are represented by a signal which decreases from 500 cps to 0 cps has been lessened. The offset was decreased 300 cps to 4450 cps. This places the offset near the theoretical value.

The equation,

$$f_c = f_o - .482\,\delta V_g - 19.1 V_B \qquad (1)$$

where f_c is the frequency correction command

f_o is the offset frequency

δ is the drift angle

V_g is ground speed

V_B is antenna beam velocity

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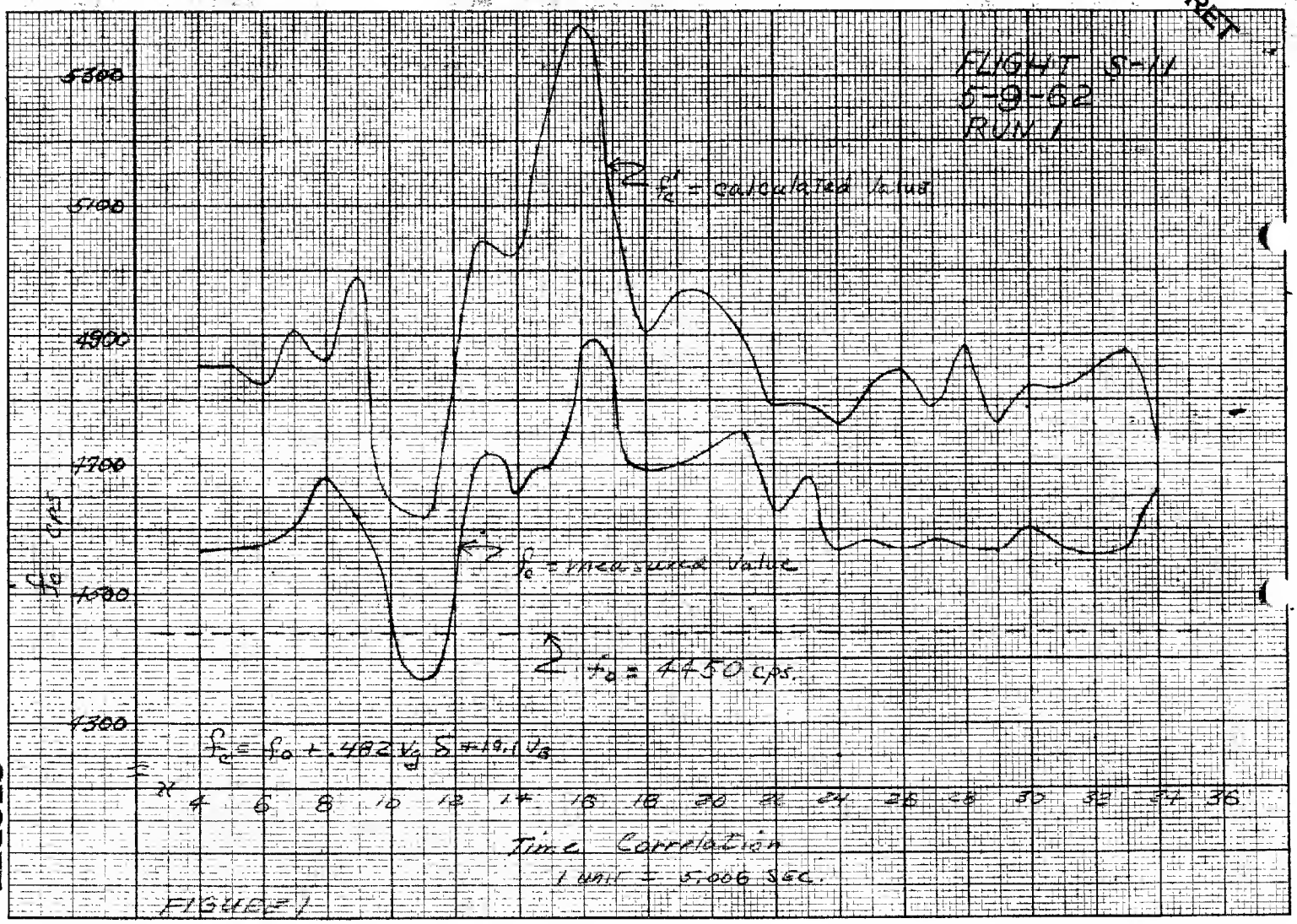

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seconds at ground speeds of 585 knots. (For 830 knots the peaks are greater, -.18 to +.10, but rise and decay times are usually less.) The sinusoidal portions have two frequencies, one at 0.8 cps, with a peak-to-peak amplitude of .04 g to .14 g and occurs about 50 percent of the time. The other at 8-10 cps, the natural lateral frequency of the pod, occurs 30 percent of the time and has peak-to-peak values of .04 g to .06 g. Both of these sinusoids occur in bursts of 9 seconds and 0.6 second for the 0.8 cps and 8-10 cps signals respectively. There is no data for characteristics of the pod in other than light or moderate turbulence.

b. Lateral Acceleration

The lateral acceleration of the pod is essentially an 8-10 cps signal, the pod's natural lateral frequency. The amplitude of this signal varies from .05 to .1 g for light turbulence at 585 knots and up to 0.16 g peak-to-peak for moderate turbulence. No non-sinusoidal characteristics could be located.

c. Vibration

At speeds of 585 knots, (M .94) the predominant frequencies range from 80-100 cps, with amplitudes from 1.0 g to 1.5 g and at 830 knots from 120-150 cps with 0.6 to 1.2 g peak-to-peak amplitude.

d. Roll

The F-101B exhibits a roll with a continual oscillation of 0.4 to 0.7 cps of .7° to 1.0° peak-to-peak amplitude. No significant changes exist when the aircraft is flown with or without the MB-5 autopilot. Little change exists between M 0.9 and M 1.5 speeds.

e. Pitch

The F-101B has a normal nose-high attitude of 1.5° to 3.0° depending on speed and fuel consumption. For 585 knots, 2.8° is the normal value. An oscillation of 0.8 cps occurs in bursts of about 9 seconds with a peak-to-peak amplitude of 0.3°. These sections of oscillations occur about 50 percent of the time.

f. Autopilot Heading Error

This signal seldom varies more than ± 1° which is within the limits of the autopilot. No predominant oscillations exist.

g. Track Error

This signal is the difference between the desired heading of the plane and the actual heading of the ground track. It is derived from the doppler navigator - ground track computer installation, (APN-102 and ASN-25). It is usually less than ± 2° but is dependent upon the pilot's ability to fly the desired heading.

h. Distance off Track

This signal is also derived from the ASN-25 and is the distance from the actual ground track to the desired ground track measured perpendicular to the desired track. Like track error, the limits are dependent upon the pilot. Experience has shown that on a good run, the signal doesn't vary more than ± .2 n. mi.

i. Pod Error

The pod error signal definitely shows the 8-10 cps oscillation occurring at the same times as this oscillation on the normal acceleration signal. The pod servo cannot follow an 8 to 10 cps oscillation. The average of the signal is 0.

j. Ground Speed

This signal is described by Figure III.

k. Drift Angle

Drift angle shows a .5 to 1 cps oscillation of amplitude of $\pm$ .25° to $\pm$ .5°. This oscillation exists continually. Figure IV shows drift angle (δ) averaged over 10 second periods.

l. Frequency Correction Command

This signal varies slowly, because of the filtered inputs, and follows δ (drift angle) closely as in equation 1 and Figure I.

m. Antenna Beam Velocity

The velocity of the antenna relative to the target usually is a slowly drifting signal of low amplitude. The signal never exceeds $\pm$ 5 feet/second, thus it has little effect on f_c of equation 1.

n. Temperatures

Below are listed the temperatures recorded at 17,000 feet:*

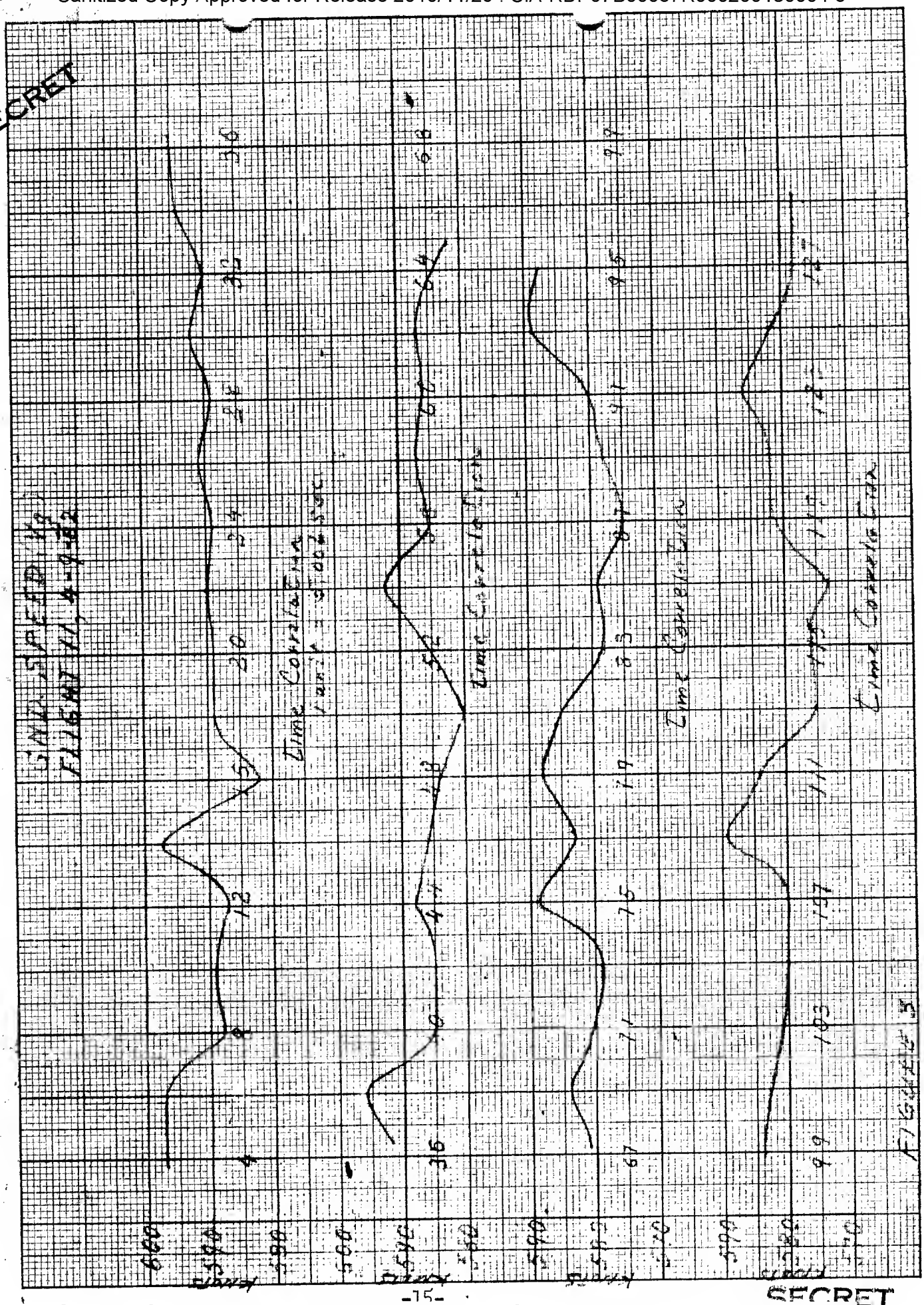
Nose Compartment Air Temperature	41°F
Duplexer Driver Surface Temperature	94°F
Duplexer Surface Temperature	100°F
Duplexer Surface Temperature (switch end)	83°F
High Voltage Power Supply Air Temperature	120°F
Pulse Network Surface Temperature	100°F

*Ambient Temperature = 0°F

4. Flights

S-8 4-24-62

Flight S-8 was composed of two runs, one westward, and one eastward over the mountain course. Good data was obtained and future offset frequencies were determined from the holograms of this flight.



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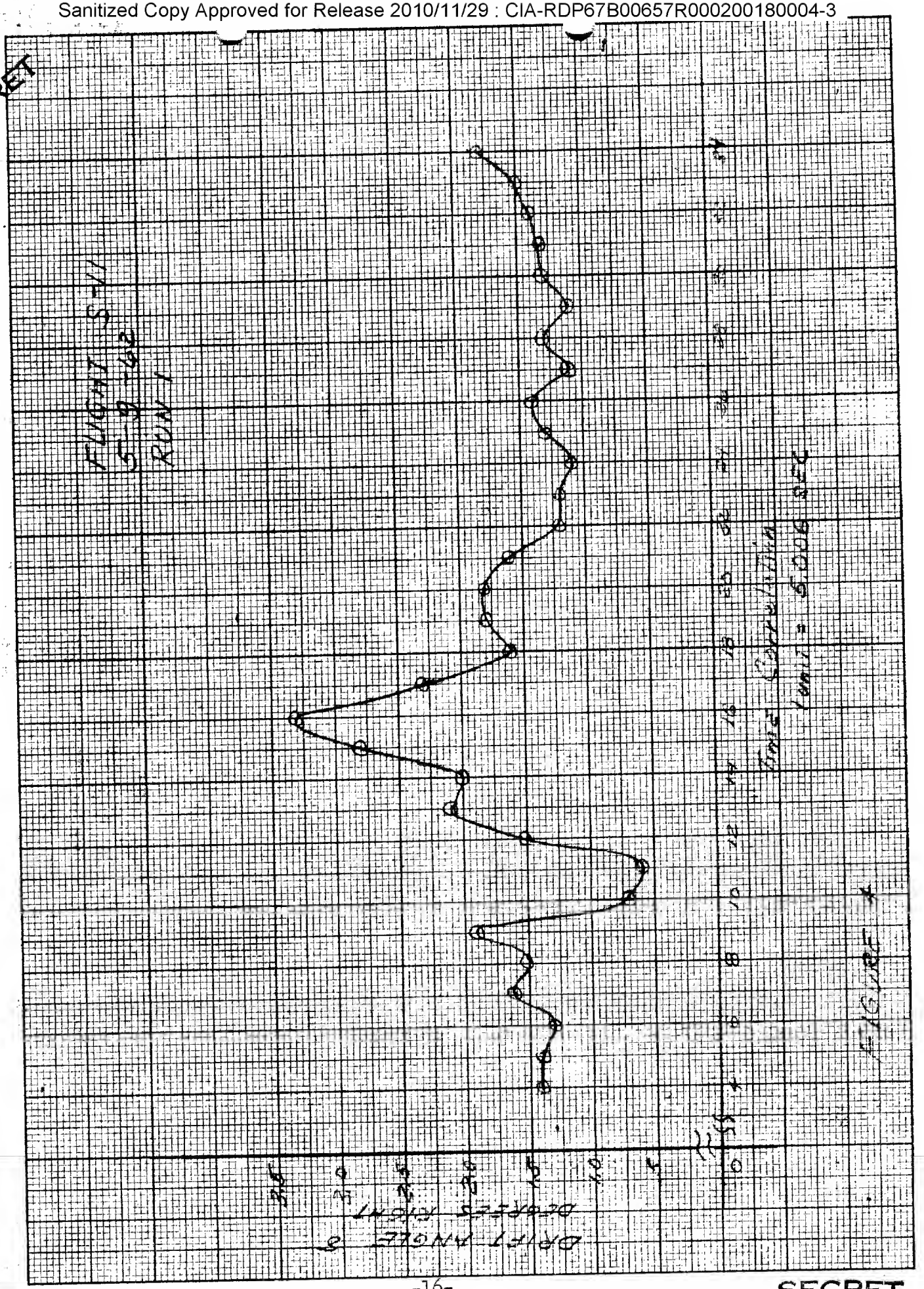

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S-9 4-29-62

Flight S-9 was flown from Baltimore to New York and down the coast at 17,000 feet and 565 knots. All oscillograph (C.E.C.) signals were normal but since little good film was produced due to low power, only brief analysis of the C.E.C. recording was performed.

S-10 5-4-62

Flight S-10 was flown over the built-up area run from Baltimore to New York, the coastline course and the Annapolis area. Failures of one aircraft voltage regulator prohibited good data. Little C.E.C. analysis of S-10 was done. Due to the moderate turbulence, larger accelerations were noticed.

S-11 5-9-62

Flight S-11 was flown at 20,000 feet over the Baltimore, Annapolis, Bay Bridge and Kent Island area. Good data was obtained in both automatic frequency correction mode and the manual mode. The holograms indicated that the offset frequency should be set up another 50 cps.

The correlation between the measured and calculated f_c for the automatic portion of S-11 is plotted in Figure 1.

Again on this flight, the aircraft voltage regulator exhibited intermittent 4 cps oscillations. This was found to be due to a broken lead in the regulator.

S-12 5-10-62

Like S-11, this flight was flown over the Baltimore, Annapolis, Kent Island area. The C.E.C. tape indicates no abnormal characteristics; however, the film showed few targets. The aircraft voltage regulator problem did not occur.

Most flights contained similar accelerations, vibrations, temperatures, and pitch and roll characteristics except for flight S-10, where larger accelerations were encountered probably due to the more turbulent air.

5. Plans

Future plans are to record antenna beam acceleration and the error signal of the doppler frequency tracker. (The doppler frequency tracker is currently being installed.) The latter signal will indicate how well the R.O. keeps the offset frequency positioned relative to the video return.

An investigation is being continued to determine why the calculated f_c in equation 1 is consistently higher than the measured value (see Figure 1). This must be known in evaluating the performance of the doppler frequency tracker.

Antenna

ANTENNA NO. 1 (Conversion of Flight Test Antenna to End Use Configuration)

Fabrication

Manifolds -	2 additional manifolds required - complete
Array Sticks -	32 additional array sticks required - complete
Modules -	2 additional modules consisting of above parts are assembled, but not soldered or grown together.
Honeycomb Beam -	complete
Power Dividers -	complete
All Hardware -	complete
Assembly and Test -	reconversion of antenna no. 1 will start at the completion of the Flight Test Program.

ANTENNA NO. 2

Fabrication - all fabrication complete

Assembly - assembly complete

Test - the antenna will be tested on the 18-19 of May. Tests will include elevation and azimuth patterns with a narrow beam transmitter. Gain will also be taken with both a wide and narrow beam transmitter.

ANTENNA NO. 3

Fabrication

Manifolds - last manifold in electrical test after two rejections are rework.

Array Sticks - complete

Modules - 7 of the 8 required modules have been assembled, tested and grown together. All seven modules have excessive leakage including those rejected and reworked at GAL. A program to seal these modules has been started with the assistance of the materials laboratory. Two solders have been found that may be suitable and are currently being tested.

The eighth module is in the process of being assembled. This module will be soldered prior to electroform, this is delayed pending results of heat and pressure tests of solders.

Honeycomb Beam - complete

Power Dividers - complete

Other parts and hardware - complete

Test and Assembly - Antenna no. 3 will be assembled as soon as the sealing problem is solved and last module is received and tested.

Switch Tubes

A "tail bite" switch (WX-4641, No. 4) has been completely tested in the laboratory was packaged in a shield can and given to the project section for further evaluation in the system. The tube was high-power tested at a repetition rate of 3500 cps and a peak power of 60 KW. Performance was good over a power range from 45 KW to 100 KW. The sweeping electrode was increased in diameter in this tube to eliminate breakdown from the domes to the electrode. From visual observations made on the No. 5 WX-4641, such arcing was found to be eliminated until the sweeping voltage exceeded the desired operational value. The operational value was found to be between 2 KV and 3 KV.

The tube did have irregular performance which was not explainable at the time the tube was tested. Recent tests on No. 5 show why the irregular performance was obtained, but as yet a way to correct the trouble has not been found. The cause of the irregularity became apparent while visually observing the discharge on tube No. 5. The discharge is changing from a "solid", intense arc to a large number of separated streamers. When this occurs, the breakdown time increases and jitter becomes worse. This was found to be a function of intensity of UV trigger and pressure but not of rf power level. On tube No. 4, a breakdown time of less than 10 nanosec.

would change to 20 ns and the jitter would increase from 3 ns to 10 ns when the change in arc intensity occurred. Consequently, tube No. 4 had an isolation of better than 9 db out to 20 ns with the irregular discharge.

Recovery time was measured for the first time on tube No. 5. For the condition of a "solid" discharge, recovery time was 1 microsecond to the 3 db point. For the irregular discharge, recovery extended to about 5 us with complete recovery at 10 microseconds.

Low level measurements on tube No. 4 indicated a VSWR of 1.23 and an insertion loss of 0.45 db.

Additional parts are at present being made to fabricate VX-4641's.

Modulator

Satisfactory operation of three modulators with the KPA has been attained. Redesigned components in the modulator have greatly increased the reliability. The pulse forming network has been changed to include 25 KV capacitors and the impedance lowered from 210 ohms to 100 ohms. The pulse transformer has been completely redesigned for better voltage insulation and lower losses. Temperature tests indicate that component heating (losses) have not been causing component failures. The thyratron trigger circuit was revised to provide better limiting of the thyratron grid spike. An inverse diode has been reinstalled to prevent a "build-up" of voltage on the pulse forming network capacitors.

Recorder

Assembly of recorder #3 was completed and acceptance test started.

Rewiring of the electronic packages and cables for recorder #2 and #4 to reduce electrical interferences is continuing.

Work on improving the resolution of the recorder continued during the month. An improvement factor of at least two has been achieved.

During the acceptance test for recorder #3 it was discovered that the high voltage power supply was causing a flutter in the trace on the cathode ray tube phosphor. Measurement of the impedance of the power supply as a function of frequency revealed a resonance at 21 cycles which modulated the focus of the cathode ray tube. This condition is believed to exist in the other supplies but of less magnitude. The power supplies have been returned to the vendor for correction.

Work on the test of a high resolution tube supplied by G.E. has been limited by the need for work on recorder #3 problems. These tests should be completed in early May. A decision as to whether it will be worth modifying the recorder to accept this tube will be made then.

Work has been started on several pieces of test equipment which are required for optimum adjustments of the recorder. These are:

(a) Resolution Test Set & Range Calibrator

(b) Light Meter

Data Flasher

The data flasher circuit has been redesigned and repackaged outside of the main recorder electronics package to avoid interference with other circuits in the main package.

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Navigation Tie-In

The fourth or spare accelerometer from Donner Scientific is being checked out according to its purchasing department specification. This unit had been rejected the first time it was received.

Changes which have been made on the gain adjust board pitch control are complete. Spare servo amplifiers, gain-adjust assembly, and summing amplifiers which are located in the synchronizer, are being checked out for the Spares Section.

Test Equipment

Design Evaluation Equipment

The rack of test equipment containing the chassis listed below has been delivered to the roof top lab:

a. Transponder
b. Range Resolution and Dynamic Range
c. Jitter Free Range Delay Circuit
d. Clutter Generator
e. Azimuth Resolution Test Pattern
f. Control Panel.

All of these units are operating satisfactorily as far as can be determined by the tests that have been performed.

Azimuth Resolution Test Pattern Generator

The new single sideband filters which were mentioned in the previous report have been received and installed in this unit. Adjustments have been made to the unit so that it will conform with the change in filter center frequency.

Range Resolution and Dynamic Range Optics Assembly

This portion of the test equipment is operating satisfactorily and has been used to evaluate some film which was exposed in the roof top testing.

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Spares

80 per cent of the spares have been packaged and are ready for shipment.

Instruction Book

Review & Editing have been completed. It is now in final typing.

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